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RATE OF GROSS ANNUAL PRODUCTION IN DOLPHIN POPULATIONS (Stenella spp. AND Delphinus delphis) IN THE EASTERN TROPICAL PACIFIC, 1973-1978

By

J. R. Henderson, W. F. Perrin and R. B. MILLER

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ADMINISTRATIVE REPORT LJ-80-02

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I. INTRODUCTION

Dolphins in the eastern tropical Pacific Ocean are incidentally killed in the purse seine fishery for yellowfin tuna. The species most involved are the spotted dolphin, Stenella attenuata, and the spinner dolphin, Stenella longirostris. Populations of these species in the fishing area are comprised of several stocks (Perrin, 1975a; Perrin, 1975b; Perrin, Sloan, and Henderson, 1979; Au, Perryman, and Perrin, 1979); the estimated boundaries are depicted in Figures 1 and 2. Species also involved in the fishery, though to a lesser extent, are the common dolphin, Delphinus delphis and the striped dolphin, Stenella coeruleoalba. Stocks of these species in the eastern tropical Pacific have been delineated (Evans, 1975; Evans, 1976; Au, et al., 1979); the estimated boundaries are presented in Figures 3 and 4. Although mortality of these latter two species is lower than that of the spotted and spinner dolphins, they are nonetheless the only major species for which mortality has ever exceeded a quota, prompting prohibition of fishing on certain stocks.¹ This impact on the fishery, together with the relative paucity of data for certain stocks of the common and the striped dolphin, increases the need for information on reproduction in these species.

Since the National Marine Fisheries Service (NMFS) began studying fishery-related mortality in 1968, life histories and gross annual production have been analyzed for several stocks: offshore spotted dolphin, S. attenuata, (Perrin, Coe, and Zweifel, 1976; and Perrin, Miller, and Sloan, 1977), eastern spinner dolphin, S. longirostris, (Perrin, Holts, and Miller, 1977), whitebelly spinner dolphin (Perrin, Holts, and Miller, 1976), and striped dolphin, S. coeruleoalba (Kimura and Perrin, 1976). This paper presents estimates of the gross annual productive rates for most stocks based on data from 1973-1978. Previously published estimates for the spotted and spinner dolphin have been reanalyzed to take into account the more recently delineated southern stocks for both species.

¹Federal Register 43(127):28502; 43(198):46975.

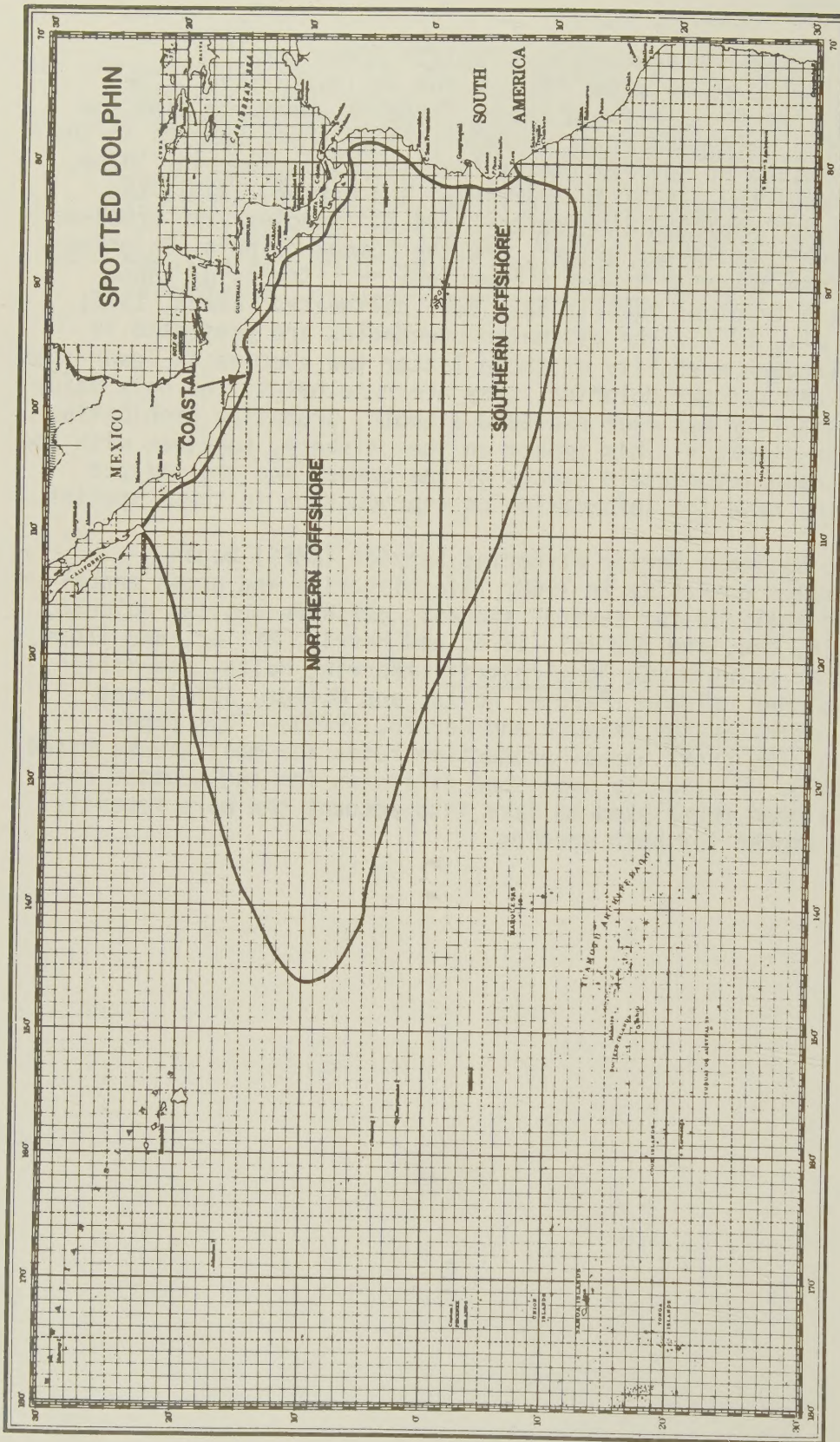


Figure 1. Stock boundaries of the spotted dolphin, *Stenella attenuata*, in the Eastern Tropical Pacific Ocean.

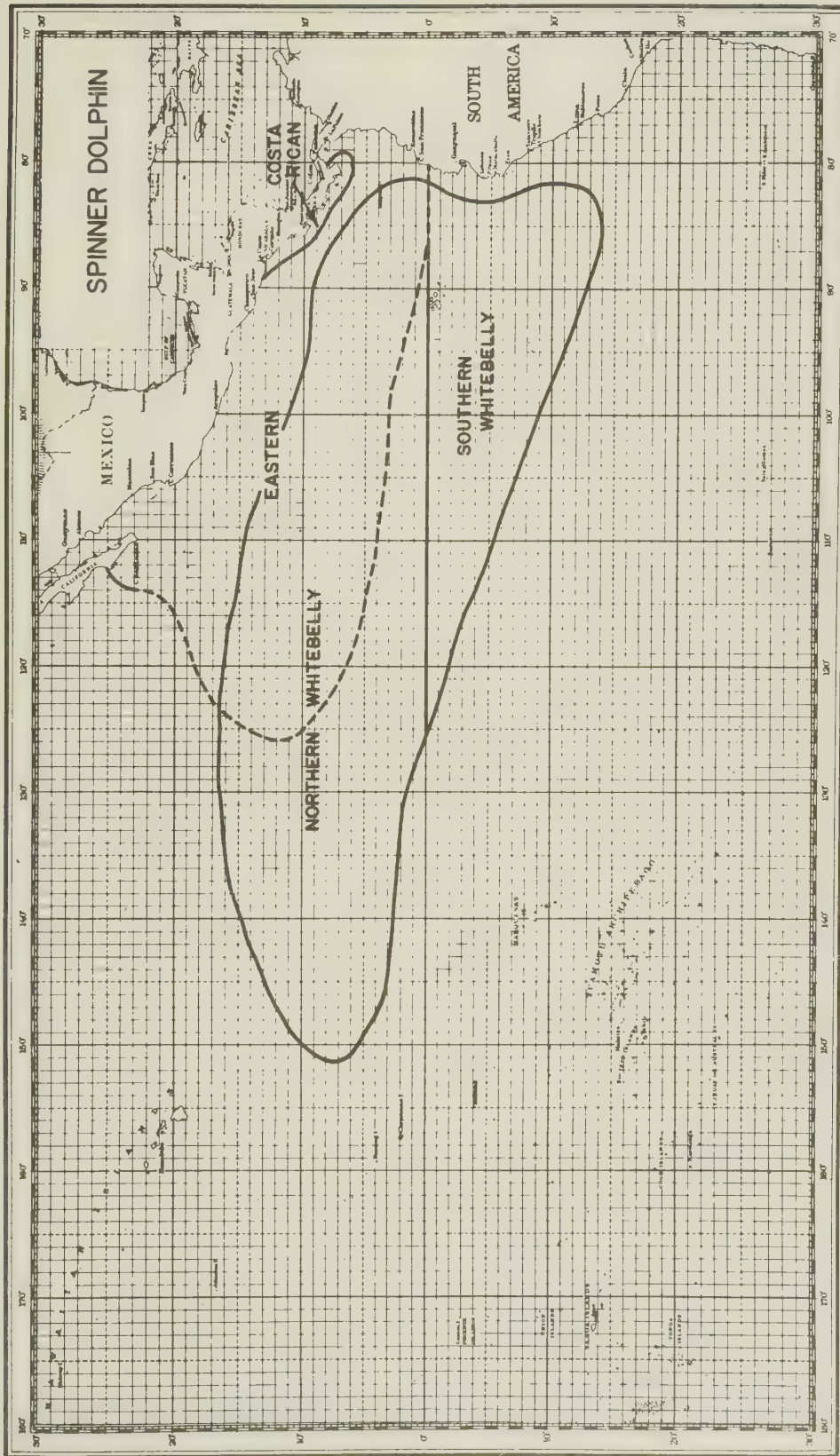


Figure 2. Stock boundaries of the spinner dolphin, Stenella longirostris, in the Eastern Tropical Pacific Ocean.

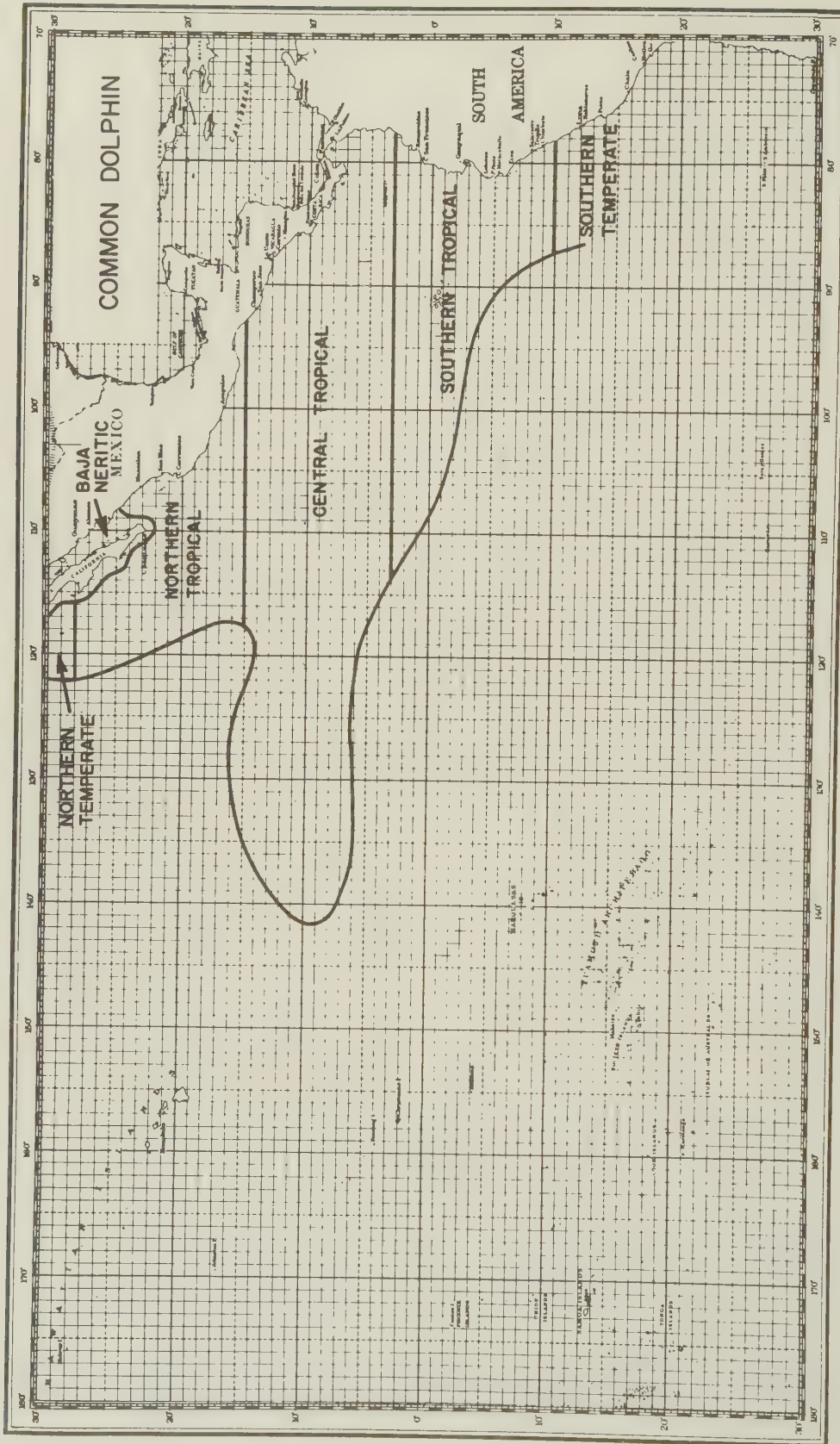


Figure 3. Stock boundaries of the common dolphin, *Delphinus delphis* in the Eastern Tropical Pacific Ocean.

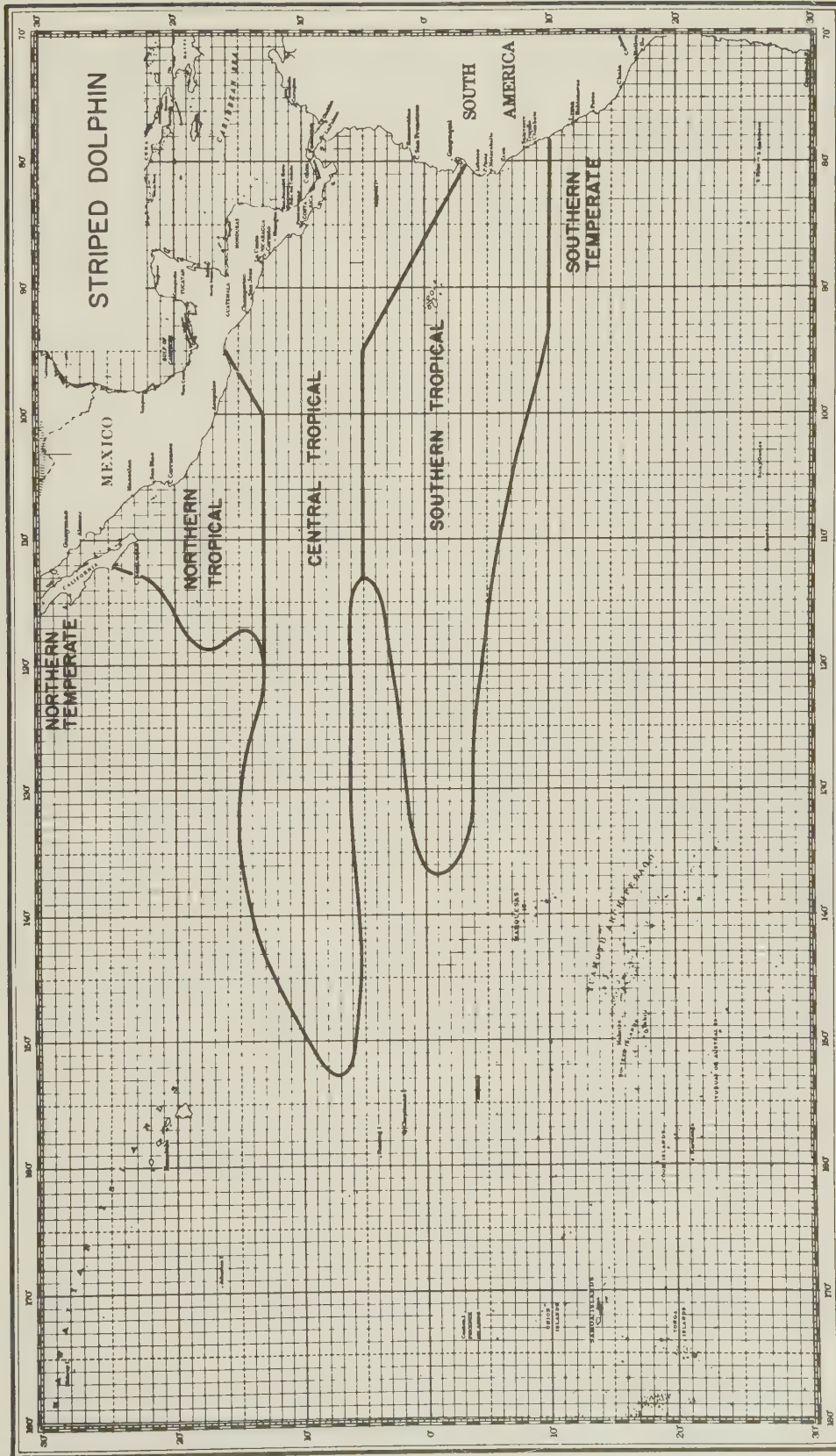


Figure 4. Stock boundaries of the striped dolphin, *Stenella coeruleoalba* in the Eastern Tropical Pacific Ocean.

II. METHODS AND MATERIALS

A. Field and Laboratory Procedure

All of the field data and specimens were collected by NMFS and Inter-American Tropical Tuna Commission observers and technicians aboard commercial tuna seiners. Field procedures were as previously described by Perrin, et al. (1976a). Data were collected on 23 cruises in 1973, 33 in 1974, 32 in 1975, 61 in 1976, 89 in 1977, and 88 in 1978. Laboratory procedures for preparing and examining gonads were as described for the spotted dolphin S. attenuata (Perrin, et al., 1976a).

B. The Sample

The number of animals for which life history data include sex, length, and position of capture is depicted in Figures 5-7. The samples from 1973-1975 of spotted dolphin and eastern spinner dolphin have been previously described (Perrin, et al., 1976a, 1977a). Because most stocks are defined or delineated geographically, we excluded from analysis animals for which position was unknown. Discrepancies in totals between Figures 5-7 and previously published plots of samples result from re-examination of the materials.

Because the methods by which we estimated gross annual production (described below) are sensitive to the number of calves in the sample, and because the number of spotted dolphin calves killed is relatively larger in sets in which fewer than 40 S. attenuata are killed (Powers and Barlow, 1979), the data for S. attenuata were limited to those specimens collected from sets in which 40 or more spotted dolphins were accidentally killed.² This bias is not significant for S. longirostris, hence no kill-per-set criteria were applied to the samples of this species.

There were insufficient data for analysis of certain stocks, namely:

1. West Central Tropical D. delphis (no specimens)
2. Southern Tropical D. delphis (7 specimens)
3. Southern Temperate D. delphis (no specimens)
4. West Central Tropical S. coeruleoalba (10 specimens)
5. Southern Tropical S. coeruleoalba (only 1 known mature female collected; Total N=56)
6. Southern Temperate S. coeruleoalba (no specimens)

C. Analysis Programs; Computer Methodology

Figure 8 depicts the computer procedures which are used to derive estimates of gross annual productive rates. All life history data

²The sample depicted in Figure 5 represents S. attenuata collected in all sets. The subsample analyzed has not been tabulated by 5° square.

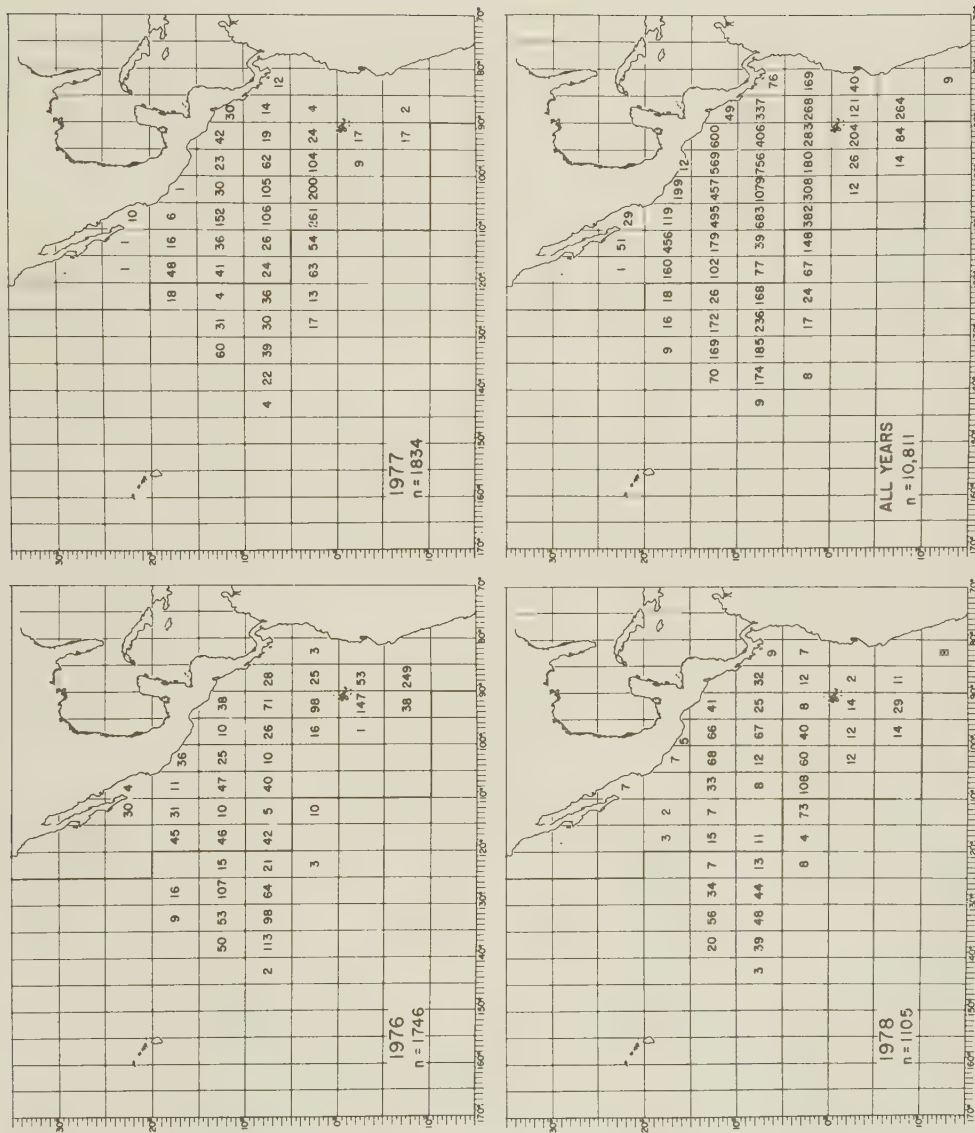


Figure 5. Samples of offshore spotted dolphin, Stenella attenuata, collected 1976-78 (totals = 1973-78) by 5° square.

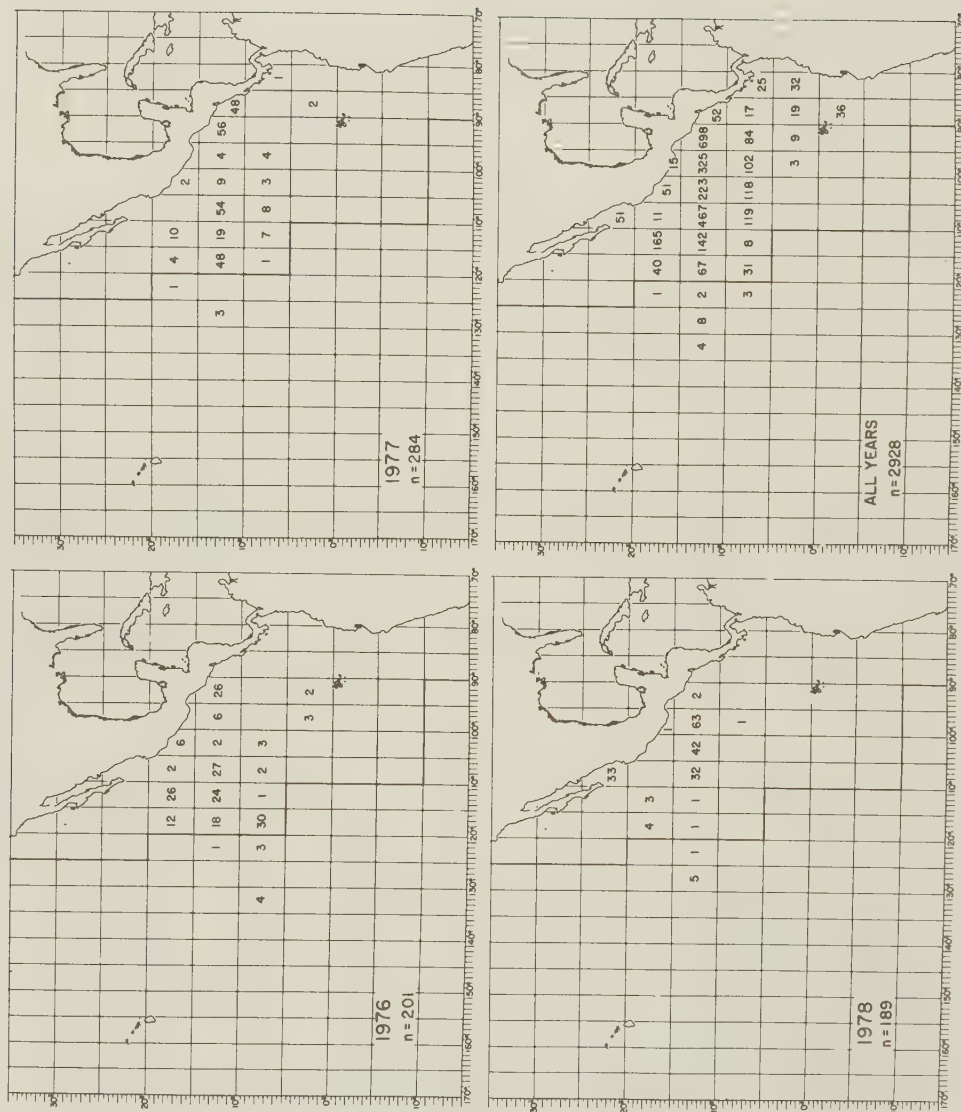


Figure 6. Samples of eastern spinner dolphin, *Stenella longirostris*, collected 1976-78 (totals = 1973-78) by 5° square (the 36 specimens south of the equator were collected from 2 sets at 0°03'S and 0°15'S respectively).

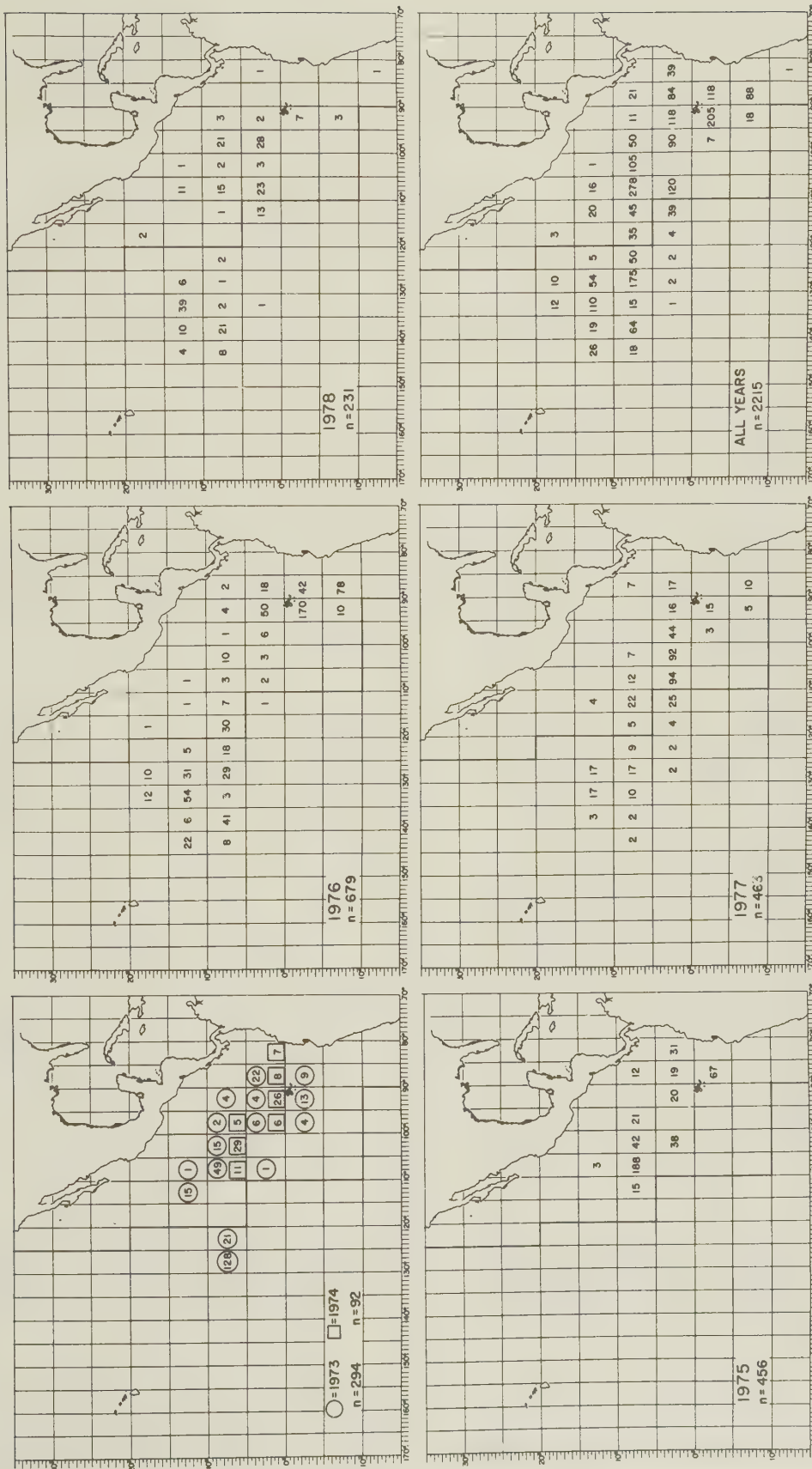


Figure 7. Samples of whitebelly spinner dolphin, *Stenella longirostris*, collected 1973-78 by 5° square.

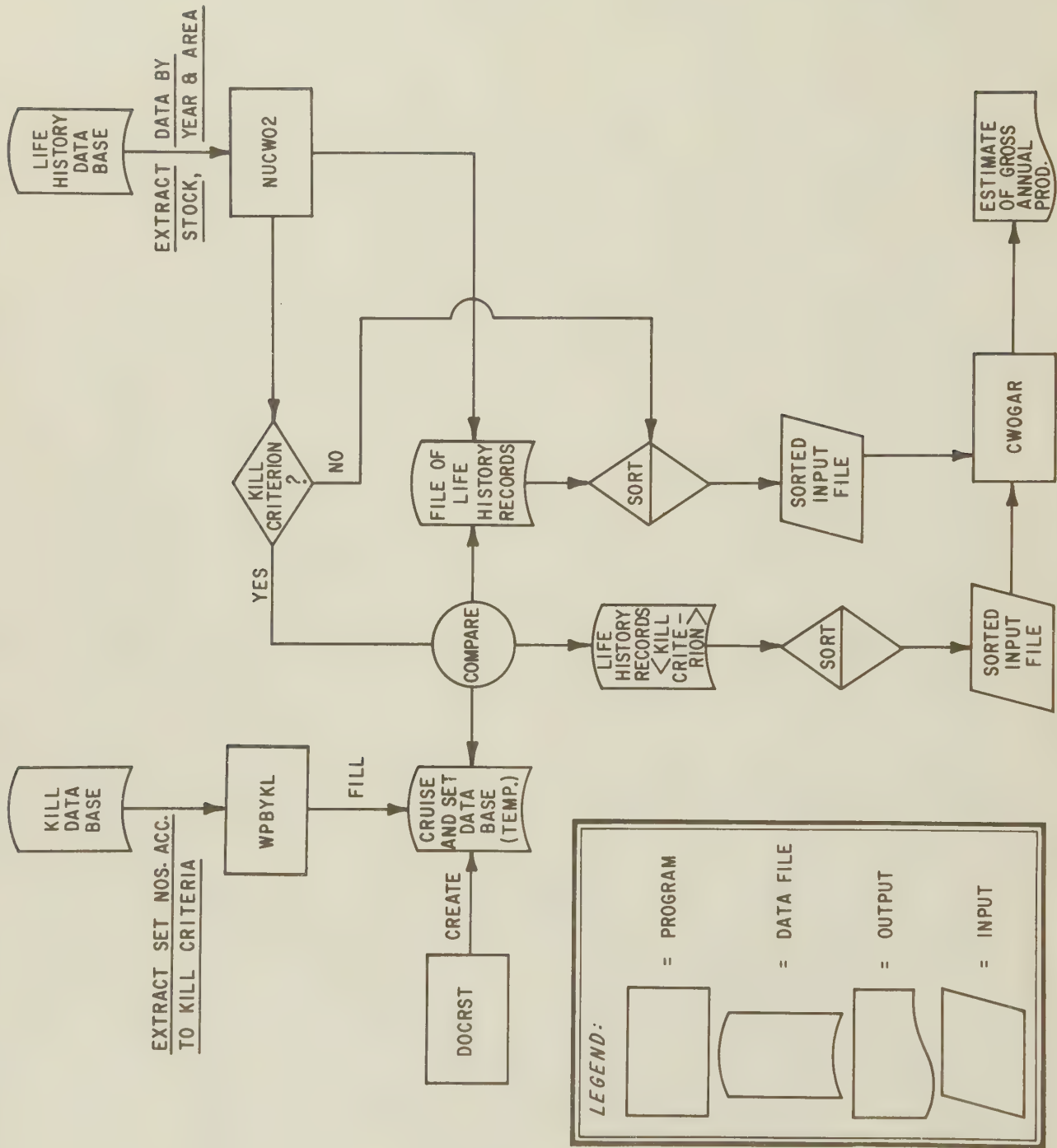


Figure 8. Schematic diagram of computer methodology used in analysis of gross annual productive rate.

are stored in data bases of the Infonet³ system at the Southwest Fisheries Center. In this study, several programs were used to access the data bases and to analyze the data. NUCW02⁴ selects from the data base those data items required to estimate gross annual production. Specimens are selected according to the criteria of: species, year(s), position within specified geographic area, and kill-per-set (if desired). These data are formatted and input into CWOGAR which performs the analyses estimating gross annual productive rate (procedures described below). If a kill-per-set criterion is desired, two additional programs must be implemented prior to execution of NUCW02. DOCRST erects a (void) data base, which is then filled by WPBYKL. WPBYKL addresses the mortality data and selects sets meeting the kill criterion input by the user. Specimen records from these sets are input into the data base created by DOCRST, which data base is in turn accessed by NUCW02.

D. Procedures for estimating calving cycle, pregnancy rate, and gross annual production

Specimens for which ovarian data were lacking or incomplete were allocated to mature or immature categories based on a length criterion. Average length at attainment of sexual maturity was estimated as that length at which the number of shorter but mature specimens in the sample equals the number of longer but immature specimens. This length estimate was derived independently for each year's data, as well as for all years' data summed. The lengths used are given with the results.

The calving cycle, for purposes of analyzing field data, can be divided into three phases: (1) pregnancy, (2) lactation, and (3) "resting" (a catch-all phase for animals neither pregnant nor lactating, which includes females truly resting, i.e., not ovulating because of being between cycles, those which have just ovulated but have not become pregnant, some with extremely small embryos missed in dissection, those which recently aborted, and those which have prematurely terminated lactation due to death of the suckling calf).

We estimated the length of the cycle (and pregnancy rate) in two ways: (1) based on the reproductive structure of the sample of adult females, i.e., based on the assumption that the samples are not biased with respect to reproductive phase, and that the proportion of a sample of mature females in a particular phase is directly proportional to the relative length of that phase, using the length of gestation as a time calibration, and (2) based on the estimate of length of gestation and a largely independent estimate of length of lactation.

The first estimate was based on data for females classified as pregnant, lactating, pregnant and lactating, "resting", or postreproductive. The "resting" females were further subdivided into those with and without a corpus luteum. Some proportion (approximately 15%-29%) of

³Reference to trade name does not imply endorsement by NOAA, NMFS.

⁴All programs are available for use or reference at the Southwest Fisheries Center, La Jolla.

those resting with a corpus luteum represents females not truly resting i.e. possessing a corpus luteum of infertile ovulation (Benirschke, et al., 1979), and a larger proportion (21%-35%) represents females possessing a corpus albicans in early stages of regression, but which was diagnosed during gross examination as a corpus luteum (op. cit.).

Subtraction of the postreproductive females from the aggregate of mature females of determined reproductive condition and allocation of the females both pregnant and lactating to both categories provides estimates of the proportions of reproductive females in the three phases of the cycle and, comparing the proportions, of the relative lengths of the phases. Estimated average length of the phases and the total cycle can then be calculated for each 1-year sample and for the pooled samples, based on the relative lengths of the phases and on the estimated gestation period.

Annual pregnancy rate under Method I is calculated as proportion of reproductive females pregnant divided by the length of gestation. The reciprocal of annual pregnancy rate is the estimate of average calving interval.

In the second method of calculating length of calving cycle, we estimated length of lactation by assuming that in the samples a suckling calf existed for each lactating female. Under this assumption, the age at which the cumulative frequency of calves in a sample equals the number of lactating females should be the average age at weaning. Since some stocks may exhibit sex-specific juvenile growth curves (Perrin and Henderson, 1979), the ages of the calves counted in this method are derived from length (separately for each sex), after which male and female calves are sorted by ascending age and serially counted until the number of lactating females is reached. If the length of lactation increases, the average age at weaning estimated by this method should increase concomitantly. To arrive at estimates of the total length of the calving cycle under Method II, we used the estimated resting period from Method I, pooling resting periods for each single-year estimation to derive a 1973-1978 "pooled resting period." In estimating pregnancy rate (as reciprocal of calving interval) overlapping cycles were taken into consideration by adjusting the effective length of lactation downward by a factor equal to the percentage of lactating females also pregnant.

"Method II" (cumulative calf age) was not used in analysis of the common dolphin, D. delphis or the striped dolphin, S. coeruleoalba, as growth curves for eastern Pacific populations have not been derived.

Estimates of gross annual reproductive rates, based on the two methods of estimating pregnancy rate, were calculated as: (proportion female) X (proportion of females reproductive) X (annual pregnancy rate). Standard errors are attached to the various estimates where sample size ≥ 100 , under the assumption that the binomial distribution tends to normality in large samples (Bailey, 1959), allowing calculation of the standard error as:

$$S. E. = \sqrt{P(1-P)/n}$$

where: p = proportion (estimate of parameter)

n = sample size.

Although gross annual reproductive rate as calculated is a product of three estimates, it can be calculated directly from the total sample (number of females pregnant $\div$ total number of males and females), to yield the same estimate and allowing estimation of the variance by the above method. The total sample size in this case was adjusted downward by a factor equal to the proportion of mature females in unknown reproductive condition.

III. RESULTS AND DISCUSSION

A. Northern Offshore Spotted Dolphin, *Senella attenuata* (from sets of ≥ 40 killed)

The results for the northern offshore spotted dolphin are presented in Tables 1-3. The gestation period was estimated at 11.5 mo. (Perrin, et al., 1976a), and the Method I pooled resting period which was input into Method II was 7.0 mo., slightly longer than the 4.6 mo. used in prior analyses (loc. cit.). The cutoff length for allocation to mature or immature of unknown-status animals ranged from 176 cm to 179 cm, with a value of 177 cm for all years considered jointly.⁵ The growth equation used in Method II was that derived by Perrin et al. (loc. cit.), and the age in years was derived from GLGs by using Hypothesis II (loc. cit.) of 2 GLGs for the first year and 1 GLG per year thereafter. The length of the calving cycle estimated by Method I (Table 1) increases steadily from 22.3 mo. in 1973 to 52.6 mo. in 1978. This increase results from a concomitant increase in lactation period from an estimated 7.6 mo. to 36.1 mo. in the same interval. This pronounced trend may be a direct effect of the dramatically decreased incidental kill over the same period (Lo and Wahlen, 1979); nursing calves are highly vulnerable (Powers and Barlow, 1979). Gross annual production (Table 3) does not mirror this trend, the effect perhaps being masked by fluctuations in the proportion female, likely a sampling artifact.

The Method II estimates of annual pregnancy rates and gross annual production do not significantly differ from Method I estimates. This differs from the results of previous analyses which used no kill-per-set criterion (Perrin, et al., 1976a) and in which Method II estimates were consistently higher, corroborating the findings of Powers, et al. (1979) that calves are over-represented in small kill-sets.

B. Southern Offshore Spotted Dolphin, *S. attenuata*

The results for the southern stock of the offshore spotted dolphin are listed in Tables 4-6. Small sample sizes precluded by-

⁵Since the cutoff length for all years' data summed differs from that of certain years considered singly, the number of individuals labeled "sexually immature" and "condition undetermined", categories which include females whose status is prorated according to a (variable) length criterion, will not add to the total shown for these categories under "73-78" in Table 1 (and subsequent Tables).

	1973 No.	1973 %	1974 No.	1974 %	1975 No.	1975 %	1976 No.	1976 %	1977 No.	1977 %	1978 No.	1978 %	1973-78 No.	1973-78 %
Sexually immature	121	40.1	94	43.3	145	42.0	106	51.2	50	48.1	29	40.3	543	43.5
Sexually mature:														
Condition undetermined	22	7.3	11	5.1	75	21.7	37	17.9	23	22.1	11	15.3	181	14.5
Pregnant only	78	25.8	30	13.8	31	9.0	16	7.7	4	3.8	7	9.7	166	13.3
Pregnant and lactating	4	1.3	6	2.8	6	1.7	3	1.4	3	2.9	0	0.0	22	1.8
Lactating only	50	16.6	60	27.6	68	19.7	35	16.9	15	14.4	22	30.6	250	20.0
"Resting"														
With corpus luteum	9	3.0	11	5.1	5	1.5	2	1.0	2	1.9	0	0.0	29	2.3
Without corpus luteum	18	6.0	5	2.3	15	4.3	7	3.4	7	6.7	3	4.2	55	4.4
Postreproductive	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0	0	0.0	1	0.1
Totals:	302	100.0	217	100.0	345	100.0	207	100.0	104	100.0	72	100.0	1247	100.0

Table 1. Reproductive condition of 1247 female northern offshore spotted dolphins, Stenella attenuata, collected 1973-1978.

Item	1973	1974	1975	1976	1977	1978	1973-1978
Sample size (no.)	159	112	125	63	31	32	522
Pregnancy (mo.)	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Lactation (mo.)							
Method 1	7.6	21.1	23.0	23.0	29.6	36.1	16.6
Method 2 (Hyp.II)	12.7	17.9	32.8	18.5	14.4	47.2	20.3
"Resting" (Method 1)	3.8	5.1	6.2	5.5	14.8	4.9	5.1
Sum of Phases:							
Method 1							
Months	22.9	37.7	40.7	40.0	55.9	52.6	33.3
Years	1.91	3.14	3.39	3.33	4.66	4.38	2.78
Method 2							
Months	31.2	36.4	51.3	37.0	32.9	65.7	37.2
Years	2.60	3.04	4.27	3.08	2.74	5.47	3.10
Annual Pregnancy Rate (APR):							
Method 1	0.538	0.335	0.309	0.315	0.236	0.228	0.376
Method 2	0.396	0.345	0.247	0.338	0.394	0.183	0.323
Calving Interval (1/APR):							
Method 1							
Years	1.86	2.98	3.24	3.18	4.24	4.38	2.66
Months	22.3	35.8	38.9	38.1	50.9	52.6	31.9
Method 2							
Months	30.3	34.8	48.6	35.5	30.5	65.7	37.2
Years	2.52	2.90	4.05	2.96	2.54	5.47	3.10

Table 2. Estimates of lengths of reproductive phases, pregnancy rate, and calving interval under two methods of estimating length of calving cycle (see text) of the northern offshore spotted dolphin, Stenella attenuata, 1973-1978.

Year	A Proportion female	B Proportion of females reproductive	C		A x B x C	
			Annual pregnancy rate Method 1	Method 2	Gross annual reproductive rate Method 1	Method 2
1973	0.557 $\pm$ 0.021 (542)	0.596 $\pm$ 0.029 (302)	0.538 $\pm$ 0.045 (159)	0.396 $\pm$ 0.039 (159)	0.179 $\pm$ 0.017 (518)	0.132 $\pm$ 0.015 (518)
1974	0.525 $\pm$ 0.025 (413)	0.567 $\pm$ 0.035 (217)	0.335 $\pm$ 0.045 (112)	0.345 $\pm$ 0.045 (112)	0.100 $\pm$ 0.015 (400)	0.103 $\pm$ 0.016 (400)
1975	0.569 $\pm$ 0.020 (610)	0.576 $\pm$ 0.030 (347)	0.309 $\pm$ 0.041 (125)	0.247 $\pm$ 0.039 (125)	0.101 $\pm$ 0.013 (527)	0.081 $\pm$ 0.012 (527)
1976	0.573 $\pm$ 0.026 (363)	0.481 $\pm$ 0.039 (208)	0.315 $\pm$ (-)* (63)	0.338 $\pm$ (-)* (63)	0.087 $\pm$ 0.016 (323)	0.093 $\pm$ 0.016 (323)
1977	0.520 $\pm$ 0.035 (200)	0.510 $\pm$ 0.055 (104)	0.236 $\pm$ (-)* (31)	0.394 $\pm$ (-)* (31)	0.062 $\pm$ 0.018 (178)	0.104 $\pm$ 0.023 (178)
1978	0.621 $\pm$ 0.045 (116)	0.597 $\pm$ (-)* (72)	0.228 $\pm$ (-)* (32)	0.183 $\pm$ (-)* (32)	0.085 $\pm$ 0.027 (107)	0.068 $\pm$ 0.024 (107)
1973-1978	0.557 $\pm$ 0.011 (2,244)	0.561 $\pm$ 0.016 (1,250)	0.376 $\pm$ 0.021 (522)	0.323 $\pm$ 0.020 (522)	0.117 $\pm$ 0.008 (2,015)	0.101 $\pm$ 0.007 (2,015)

* Insufficient data

** No specimens

Table 3. Calculation of estimates of gross annual reproductive rate of northern offshore spotted dolphin, *Stenella attenuata*, for 1973-1978, using two alternative estimates of pregnancy rate (see text). Standard error follows estimate (see text). Sample size in parentheses.

year estimates for only those sets with kill ≥ 40 ; the by-year estimates should be considered accordingly as biased. The estimates for 1973-78 pooled are presented both for all sets and for sets with kill ≥ 40 .

The inputs (gestation, growth equations, and age hypothesis) were the same as described above for the northern stock. The Method I pooled resting period input into Method II was 7.0 mo. (the value used for the northern stock). The cutoff length for allocation of unknown animals to mature or immature ranged from 173 cm to 176 cm, with a value of 173 cm for all years jointly. This is smaller than that used for the northern stock, and is consonant with the average smaller adult size in the southern stock (Perrin, et al., 1978b).

The proportion of females reproductive in the southern stock (Table 6) is consistently higher than in the northern stock (Table 3) ranging from 0.624 to 0.725, with the estimates for all years 0.631 and 0.646. There are also consistently fewer immature animals in our samples of the southern stock than in the northern stock. Except for the Method II estimate for 1976, the by-year estimates of gross production are consistently higher for the southern population than for the northern. The Method I estimate for Gross Annual Reproductive Rate for 1973-78 pooled (sets with kill ≥ 40) for the southern population is 19.5% versus 11.7% in the northern, a difference statistically different at $\alpha < 0.05$. The Method II estimates (9.8% versus 10.1%) are virtually identical in the two populations.

The larger proportion of immature females in the northern population may be an effect of the incidental exploitation by the tuna fishery, which has led to reduction of the population by about a third (SWFC, 1976). The difference may also be partly due to seasonal bias in sampling, as tuna seining only occurs sporadically south of the equator. Given the long gestation period and diffuse nature of reproductive seasonality in the species (Barlow, 1979), the seasonal bias is likely to be inconsequential. In any case, the results of these analyses do not support the assumption (SWFC, 1976) of density-dependent increase in gross reproductive rate in the heavily-exploited northern population.

C. Eastern Spinner Dolphin, *S. longirostris*

The results for the eastern spinner dolphin are listed in Tables 7-9. The gestation period was estimated at 10.6 mo. (Perrin, et al., 1977b), and the Method I pooled resting period estimate input into Method II was 6.0 mo., close to the 5.5 mo. used in previous analyses (loc. cit.). The growth equation for Method II analyses was that derived in prior analyses (loc. cit.), as was Hypothesis II of rates of GLG accumulation per year (1 1/2 GLGs the first year, 1 per year thereafter).

The cutoff lengths for allocation of unknown animals ranged from 165 cm to 170 cm, with a length of 166 cm for all years jointly.

The Method II estimates of annual pregnancy rate (Table 8) are consistently higher than Method I estimates. (The 1978 Method I estimate likely results from a small sample and artificially short resting and lactation periods.) Although Powers, et al. (1979) found no significant bias towards selection of eastern spinner calves in small kill sets, this trend

does exist (loc. cit.), and the lack of significance may result from the smaller sample of eastern spinners. Thus, the Method II results (Tables 8 and 9) may be inflated by the same type of bias which was corrected for in the spotted dolphin.

D. Northern Whitebelly Spinner Dolphin, *S. longirostris*

The results for the northern whitebelly spinner dolphin are presented in Tables 10-12. The gestation period was estimated at 10.6 mo. (Perrin, et al., 1977b); and the Method I pooled resting period which was input into Method II was 8.1 mo. The growth equations used for Method II analyses (separate curves for juvenile males and females) were those derived by Perrin, et al. (1979a), and the hypothesis for deriving age from GLGs was as above for the eastern spinner dolphin.

The cutoff length for allocating animals of unknown status to mature and immature categories ranged from 169 cm to 173 cm, with a value of 170 cm for all years considered jointly, a value 4 cm greater than that used for eastern spinners, and consonant with the 4 cm difference in average length of females between the two stocks (Perrin, et al., 1976b, 1977a). Perrin, et al. (1979a) compare growth and reproduction in the eastern and northern whitebelly spinner populations.

E. Southern Whitebelly Spinner Dolphin, *S. longirostris*

Results for the southern whitebelly spinner are listed in Tables 13-15. Input values for gestation, growth equations, and the age versus GLG hypothesis were as described above for the eastern spinner dolphin. The cutoff length for allocating animals of unknown status to mature and immature categories was 172 cm for 1975 sample, and 170 cm for the 1976 sample and for all years summed. The Method I pooled resting period input into Method II calculations was 15.7 mo., a value twice that of the northern stock and causing the depressed values for Method II estimates (Table 15). Method I estimates are within the range of those derived for the northern stock (Table 12) and are likely more accurate. There are no significant differences between the northern and southern populations in either of the two estimates of gross annual reproductive rate, which may indicate (1) the two populations are similar fractions of their original size, or (2) their statuses are different, but there has been no density-dependent increase in reproductive rate in the northern, more heavily exploited population.

F. Common Dolphin, *Delphinus delphis*

The results for three stocks (north tropical, Baja Neritic, and east central tropical) as well as for all stocks combined of *D. delphis* are listed in Tables 16-27. There is considerable overlap in range between the Baja neritic and the north tropical populations. Hence the analysis of specimens from these two stocks (as determined from a geographic criterion) likely includes some individuals from the adjacent stock. Data were insufficient for analyses in several years for each individual stock.

In the absence of an estimate of gestation period, we provisionally used the value derived for the spotted dolphin, *S. attenuata*, 11.5 mo.

	1973*		1974**		1975		1976		1977*		1978		All Sets 1973-78		Kill >40 1973-78	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	
Sexually immature	---		---		19	35.8	95	37.3	---		11	21.6	143	35.7	55	34.8
Sexually mature:																
Condition																
undetermined	---		---		7	13.2	22	8.6	---		19	37.3	55	13.7	9	5.7
Pregnant only	---		---		7	13.2	66	25.9	---		4	7.8	87	21.7	45	28.5
Pregnant and lactating	---		---		2	3.8	3	1.2	---		1	2.0	6	1.5	2	1.3
Lactating only	---		---		12	22.6	56	22.0	---		12	23.5	84	20.9	35	22.2
"Resting"																-19-
With corpus luteum	---		---		2	3.8	5	2.0	---		1	2.0	10	2.5	3	1.9
Without corpus luteum	---		---		4	7.5	8	3.1	---		3	5.9	16	4.0	9	5.7
Postreproductive	---		---		0	0.0	0	0.0	---		0	0.0	0	0.0	0	0.0
Totals:	---		---		53	100.0	255	100.0	---		51	100.0	401	100.0	158	100.0

★ Insufficient data

* No specimens

Table 4. Reproductive condition of 401 female southern offshore spotted dolphins, *Stenella attenuata*, collected 1973-1978.

Item	1973*	1974**	1975	1976	1977*	1978	All Sets 1973-1978	Sets of kill >40 1973-1978
Sample size (no.)	--	--	27	138	--	21	203	94
Pregnancy (mo.)	--	--	11.5	11.5	--	11.5	11.5	11.5
Lactation (mo.)								
Method 1	--	--	17.9	9.8	--	29.9	11.1	9.1
Method 2 (Hyp.II)	--	--	21.5	35.9	--	42.5	34.9	29.1
"Resting" (Method 1)	--	--	7.7	2.2	--	9.2	3.2	7.0
Sum of Phases:								
Method 1								
Months	--	--	37.1	23.5	--	50.6	25.8	23.5
Years	--	--	3.09	1.96	--	4.22	2.15	1.96
Method 2								
Months	--	--	40.0	54.4	--	61.0	53.4	47.6
Years	--	--	3.33	4.53	--	5.08	4.45	3.96
Annual Pregnancy Rate (APR):								
Method 1	--	--	0.348	0.522	--	0.249	0.478	0.522
Method 2	--	--	0.325	0.228	--	0.208	0.235	0.261
Calving Interval (1/APR):								
Method 1								
Years	--	--	2.88	1.92	--	4.03	2.09	1.92
Months	--	--	34.5	23.0	--	48.3	25.1	23.0
Method 2								
Months	--	--	36.9	52.5	--	57.7	51.1	46.0
Years	--	--	3.08	4.38	--	4.81	4.26	3.83

* Insufficient data

** No specimens

Table 5. Estimates of lengths of reproductive phases, pregnancy rate, and calving interval under two methods of estimating length of calving cycle (see text) of the southern offshore spotted dolphin, Stenella attenuata, 1973-1978.

Year	A Proportion female	B Proportion of females reproductive	C		A x B x C	
			Annual pregnancy rate Method 1	Method 2	Gross annual reproductive rate Method 1	Method 2
1973*	--- (30)	---	---	---	---	---
1974**	---	---	---	---	---	---
1975	0.570 $\pm$ (-)* (93)	0.642 $\pm$ (-)* (53)	0.348 $\pm$ (-)* (27)	0.325 $\pm$ (-)* (27)	0.127 $\pm$ (-)* (88)	0.119 $\pm$ (-)* (88)
1976	0.570 $\pm$ 0.023 (447)	0.624 $\pm$ 0.031 (255)	0.522 $\pm$ 0.043 (138)	0.228 $\pm$ 0.036 (138)	0.186 $\pm$ 0.019 (431)	0.081 $\pm$ 0.013 (431)
1977*	--- (44)	---	---	---	---	---
1978	0.560 $\pm$ (-)* (91)	0.725 $\pm$ (-)* (51)	0.249 $\pm$ (-)* (21)	0.208 $\pm$ (-)* (21)	0.101 $\pm$ (-)* (75)	0.084 $\pm$ 0.011 (75)
1973-1978 (All sets)	0.570 $\pm$ 0.019 (704)	0.631 $\pm$ 0.026 (401)	0.478 $\pm$ 0.035 (203)	0.235 $\pm$ 0.030 (203)	0.172 $\pm$ 0.015 (656)	0.084 $\pm$ 0.011 (656)
1973-1978 (Sets of >40 kill)	0.579 $\pm$ 0.030 (273)	0.646 $\pm$ 0.039 (158)	0.522 $\pm$ (-)* (94)	0.261 $\pm$ (-)* (94)	0.195 $\pm$ 0.024 (265)	0.098 $\pm$ 0.018 (265)

*Insufficient data

**No specimens

Table 6. Calculation of estimates of gross annual reproductive rate of the southern offshore spotted dolphin, *Stenella attenuata*, for 1973-1978, using two alternative estimates of pregnancy rate (see text). Standard error follows estimate (see text). Sample size in parentheses.

	1973		1974		1975		1976		1977		1978		1973-78	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Sexually immature	187	54.4	219	55.3	229	57.0	63	59.4	89	59.7	65	70.7	838	56.3
Sexually mature:														
Condition undetermined	19	5.5	15	3.8	26	6.5	11	10.4	29	19.5	12	13.0	125	8.4
Pregnant only	27	7.8	54	13.6	47	11.7	8	7.5	7	4.7	6	6.5	149	10.0
Pregnant and lactating	1	0.3	2	0.5	1	0.2	0	0.0	1	0.7	2	2.2	7	0.5
Lactating only	82	23.8	78	19.7	73	18.2	21	19.8	17	11.4	6	6.5	277	18.6
"Resting"														
With corpus luteum	3	0.9	10	2.5	4	1.0	1	0.9	1	0.7	0	0.0	19	1.3
Without corpus luteum	24	7.0	15	3.8	22	5.5	2	1.9	5	3.4	1	1.1	69	4.6
Postreproductive	1	0.3	3	0.8	0	0.0	0	0.0	0	0.0	0	0.0	4	0.3
Totals:	344	100.0	396	100.0	402	100.0	106	100.0	149	100.0	92	100.0	1,488	100.0

Table 7. Reproductive condition of 1,488 female eastern spinner dolphins, Stenella longirostris, collected 1973-1978.

Item	1973	1974	1975	1976	1977	1978	1973-1978
Sample size (no.)	137	159	147	32	31	15	521
Pregnancy (mo.)	10.6	10.6	10.6	10.6	10.6	10.6	10.6
Lactation (mo.)							
Method 1	31.4	15.1	16.3	27.8	23.9	10.6	19.3
Method 2 (Hyp.II)	11.5	9.3	9.8	17.4	11.2	11.2	10.6
"Resting" (Method 1)	10.2	4.7	5.7	4.0	8.0	1.3	6.0
Sum of Phases:							
Method 1							
Months	52.2	30.5	32.7	42.4	42.4	22.5	35.9
Years	4.35	2.54	2.72	3.53	3.53	1.88	2.99
Method 2							
Months	28.1	25.9	26.3	34.0	27.8	27.8	27.1
Years	2.34	2.16	2.20	2.83	2.32	2.32	2.26
Annual Pregnancy Rate (APR):							
Method 1	0.231	0.399	0.370	0.283	0.292	0.604	0.339
Method 2	0.430	0.468	0.458	0.353	0.441	0.480	0.446
Calving Interval (1/APR):							
Method 1							
Years	4.32	2.51	2.71	3.53	3.42	1.66	2.95
Months	51.9	30.1	32.5	42.4	41.1	19.9	35.4
Method 2							
Months	27.9	25.7	26.2	34.0	27.2	25.0	26.9
Years	2.33	2.14	2.19	2.83	2.27	2.08	2.24

Table 8. Estimates of lengths of reproductive phases, pregnancy rate, and calving interval under two methods of estimating length of calving cycle (see text) of the eastern spinner dolphin, Stenella longirostris, 1973-1978.

Year	A Proportion female	B Proportion of females reproductive	C		A x B x C	
			Annual pregnancy rate		Gross annual reproductive rate	
			Method 1	Method 2	Method 1	Method 2
1973	0.498 $\pm$ 0.019 (693)	0.452 $\pm$ 0.028 (345)	0.231 $\pm$ 0.036 (137)	0.430 $\pm$ 0.042 (137)	0.052 $\pm$ 0.009 (663)	0.098 $\pm$ 0.011 (663)
1974	0.498 $\pm$ 0.018 (797)	0.436 $\pm$ 0.026 (397)	0.399 $\pm$ 0.039 (159)	0.468 $\pm$ 0.040 (159)	0.087 $\pm$ 0.010 (768)	0.102 $\pm$ 0.011 (768)
1975	0.527 $\pm$ 0.018 (764)	0.429 $\pm$ 0.026 (403)	0.370 $\pm$ 0.040 (147)	0.458 $\pm$ 0.041 (147)	0.084 $\pm$ 0.010 (727)	0.104 $\pm$ 0.011 (727)
1976	0.527 $\pm$ 0.035 (201)	0.406 $\pm$ 0.050 (106)	0.283 $\pm$ (-)* (32)	0.353 $\pm$ (-)* (32)	0.061 $\pm$ 0.017 (190)	0.076 $\pm$ 0.019 (190)
1977	0.527 $\pm$ 0.030 (284)	0.403 $\pm$ 0.051 (149)	0.292 $\pm$ (-)* (31)	0.441 $\pm$ (-)* (31)	0.062 $\pm$ 0.016 (227)	0.093 $\pm$ 0.019 (227)
1978	0.487 $\pm$ 0.036 (189)	0.293 $\pm$ (-)* (92)	0.604 $\pm$ (-)* (15)	0.480 $\pm$ (-)* (15)	0.086 $\pm$ 0.022 (159)	0.069 $\pm$ 0.020 (159)
1973-1978	0.510 $\pm$ 0.009 (2,938)	0.432 $\pm$ 0.014 (1,492)	0.339 $\pm$ 0.021 (521)	0.446 $\pm$ 0.022 (521)	0.075 $\pm$ 0.005 (2,624)	0.098 $\pm$ 0.006 (2,624)

* Insufficient data

Table 9. Calculation of estimates of gross annual reproductive rate of the eastern spinner dolphin, *Stenella longirostris*, for 1973-1978, using two alternative estimates of pregnancy rate (see text). Standard error follows estimate (see text). Sample size in parentheses.

	1973		1974		1975		1976		1977		1978		1973-78	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Sexually immature	65	48.9	20	40.8	87	45.5	101	52.9	107	48.2	59	50.0	428	47.3
Sexually mature:														
Condition undetermined	2	1.5	3	6.1	15	7.9	21	11.0	37	16.7	18	15.3	108	11.9
Pregnant only	19	14.3	7	14.3	34	17.8	17	8.9	24	10.8	5	4.2	106	11.7
Pregnant and lactating	2	1.5	1	2.0	3	1.6	0	0.0	2	0.9	1	0.8	9	1.0
Lactating only	31	23.3	7	14.3	35	18.3	31	16.2	39	17.6	21	17.8	164	18.1
"Resting"														
With corpus luteum	8	6.0	4	8.2	2	1.0	9	4.7	5	2.3	1	0.8	29	3.2
Without corpus luteum	6	4.5	5	10.2	15	7.9	12	6.3	7	3.2	13	11.0	58	6.4
Postreproductive	0	0.0	2	4.1	0	0.0	0	0.0	1	0.5	0	0.0	3	0.3
Totals:	133	100.0	49	100.0	191	100.0	191	100.0	222	100.0	118	100.0	905	100.0

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Table 10. Reproductive condition of 905 female northern whitebelly spinner dolphins, Stenella longirostris, collected 1973-1978.

Item	1973	1974	1975	1976	1977	1978	1973-1978
Sample size (no.)	66	24	89	69	77	41	366
Pregnancy (mo.)	10.6	10.6	10.6	10.6	10.6	10.6	10.6
Lactation (mo.)							
Method 1	16.7	10.6	10.9	19.3	16.7	38.9	16.0
Method 2 (Hyp.II)	13.4	24.0	14.6	14.9	12.8	21.3	18.5
"Resting" (Method 1)	7.1	11.9	4.9	13.1	4.9	24.7	8.0
Sum of Phases:							
Method 1							
Months	34.3	33.1	26.4	43.0	32.2	74.2	34.6
Years	2.86	2.76	2.20	3.59	2.68	6.18	2.88
Method 2							
Months	32.1	42.7	33.3	33.6	31.5	40.0	37.2
Years	2.68	3.56	2.78	2.80	2.62	3.33	3.10
Annual Pregnancy Rate (APR):							
Method 1	0.360	0.377	0.471	0.279	0.382	0.166	0.356
Method 2	0.384	0.302	0.373	0.357	0.389	0.308	0.332
Calving Interval (1/APR):							
Method 1							
Years	2.78	2.65	2.13	3.59	2.62	6.04	2.81
Months	33.3	31.8	25.5	43.0	31.4	72.4	33.7
Method 2							
Months	31.3	39.7	32.1	33.6	30.9	39.0	36.2
Years	2.61	3.31	2.68	2.8	2.57	3.25	3.02

Table 11. Estimates of lengths of reproductive phases, pregnancy rate, and calving interval under two methods of estimating length of calving cycle (see text) of the northern whitebelly spinner dolphin, Stenella longirostris, 1973-1978.

A

B

C

A x B x C

Year	Proportion female	Proportion of females reproductive	Annual pregnancy rate		Gross annual reproductive rate	
			Method 1	Method 2	Method 1	Method 2
1973	0.496 $\pm$ 0.031 (268)	0.504 $\pm$ 0.044 (133)	0.360 $\pm$ (-)* (66)	0.384 $\pm$ (-)* (66)	0.090 $\pm$ 0.018 (263)	0.096 $\pm$ 0.018 (263)
1974	0.533 $\pm$ (-)* (92)	0.551 $\pm$ (-)* (49)	0.377 $\pm$ (-)* (24)	0.302 $\pm$ (-)* (24)	0.111 $\pm$ (-)* (87)	0.089 $\pm$ (-)* (87)
1975	0.491 $\pm$ 0.025 (389)	0.545 $\pm$ 0.038 (191)	0.471 $\pm$ (-)* (89)	0.373 $\pm$ (-)* (89)	0.126 $\pm$ 0.017 (371)	0.100 $\pm$ 0.016 (371)
1976	0.506 $\pm$ 0.026 (378)	0.466 $\pm$ 0.038 (191)	0.279 $\pm$ (-)* (69)	0.357 $\pm$ (-)* (69)	0.066 $\pm$ 0.013 (356)	0.084 $\pm$ 0.015 (356)
1977	0.519 $\pm$ 0.024 (430)	0.511 $\pm$ 0.039 (223)	0.382 $\pm$ (-)* (77)	0.389 $\pm$ (-)* (77)	0.101 $\pm$ 0.016 (373)	0.103 $\pm$ 0.016 (373)
1978	0.534 $\pm$ 0.034 (221)	0.500 $\pm$ 0.052 (118)	0.166 $\pm$ (-)* (41)	0.308 $\pm$ (-)* (41)	0.044 $\pm$ 0.015 (196)	0.082 $\pm$ 0.020 (196)
1973-1978	0.509 $\pm$ 0.012 (1,778)	0.522 $\pm$ 0.018 (905)	0.356 $\pm$ 0.025 (366)	0.356 $\pm$ 0.025 (366)	0.094 $\pm$ 0.007 (1,631)	0.088 $\pm$ 0.007 (1,631)

* Insufficient data

Table 12. Calculation of estimates of gross annual reproductive rate of the northern whitebelly spinner dolphin, *Stenella longirostris*, for 1973-1978, using two alternative estimates of pregnancy rate (see text). Standard error follows estimate (see text). Sample size in parentheses.

	1973*	1974**	1975	1976	1977*	1978*	1973-78
	No.	No.	No.	No.	No.	No.	No.
	%	%	%	%	%	%	%
Sexually immature			12	60			82
			44.4	35.9			36.1
Sexually mature:							
Condition undetermined			0	19			22
Pregnant only			7	17			30
Pregnant and lactating			0	1			2
Lactating only			6	31			42
"Resting"							
With corpus luteum			1	27			32
Without corpus luteum			1	12			17
Postreproductive			0	0			0
			0.0	0.0			0.0
Totals:			27	167			227
			100.0	100.0			100.0

* Insufficient data

** No specimens

Table 13. Reproductive condition of 227 female southern whitebelly spinner dolphins, Stenella longirostris, collected 1973-1978.

Item	1973*	1974**	1975	1976	1977*	1978*	1973-1978
Sample size (no.)	--	--	15	18	--	--	123
Pregnancy (mo.)	--	--	10.6	10.6	--	--	10.6
Lactation (mo.)	--						
Method 1	--	--	9.1	18.8	--	--	14.6
Method 2 (Hyp.II)	--	--	27.2	41.4	--	--	33.8
"Resting" (Method 1)	--	--	3.0	23.0	--	--	16.2
Sum of Phases:							
Method 1							
Months	--	--	22.7	52.4	--	--	41.4
Years	--	--	1.89	4.37	--	--	3.45
Method 2							
Months	--	--	54.5	67.7	--	--	60.1
Years	--	--	4.46	5.64	--	--	5.01
Annual Pregnancy Rate (APR):							
Method 1	--	--	0.528	0.232	--	--	0.295
Method 2	--	--	0.224	0.181	--	--	0.205
Calving Interval (1/APR):							
Method 1							
Years	--	--	1.89	4.32	--	--	3.40
Months	--	--	22.7	51.8	--	--	40.7
Method 2							
Months	--	--	54.5	66.4	--	--	58.6
Years	--	--	4.46	5.54	--	--	4.88

* Insufficient data

** No specimens

Table 14. Estimates of lengths of reproductive phases, pregnancy rate, and calving interval under two methods of estimating length of calving cycle (see text) of the southern whitebelly spinner dolphin, Stenella longirostris, 1973-1978.

Year	A Proportion female	B Proportion of females reproductive	C		A x B x C	
			Annual pregnancy rate		Gross annual reproductive rate	
			Method 1	Method 2	Method 1	Method 2
1973*	--- (26)	---	---	---	---	---
1974**	---	---	---	---	---	---
1975	0.403 $\pm$ (-)* (67)	0.556 $\pm$ (-)* (27)	0.528 $\pm$ (-)* (15)	0.224 $\pm$ (-)* (15)	0.118 $\pm$ (-)* (67)	0.050 $\pm$ (-)* (67)
1976	0.560 $\pm$ 0.029 (298)	0.629 $\pm$ 0.039 (167)	0.232 $\pm$ (-)* (88)	0.181 $\pm$ (-)* (88)	0.082 $\pm$ 0.016 (284)	0.064 $\pm$ 0.014 (284)
1977*	--- (33)	---	---	---	---	---
1978*	--- (10)	---	---	---	---	---
1973-1978	0.522 $\pm$ 0.024 (435)	0.630 $\pm$ 0.034 (227)	0.295 $\pm$ 0.041 (123)	0.205 $\pm$ 0.036 (123)	0.097 $\pm$ 0.014 (416)	0.067 $\pm$ 0.012 (416)

* Insufficient data

** No specimens

Table 15. Calculation of estimates of gross annual reproductive rate of the southern whitebelly spinner dolphin, *Stenella longirostris*, for 1973-1978, using two alternative estimates of pregnancy rate (see text). Standard error follows estimate (see text). Sample size in parentheses.

G. Striped Dolphin, Stenella coeruleoalba

Results for the striped dolphin, S. coeruleoalba are listed in Tables 28-33. Data from most stocks are too sparse for analysis, and only in 1975 were sufficient samples collected for derivation of a single-year estimate. The estimated gestation period we used was that for S. attenuata, 11.5 mo.

	1973 No. %	1974** No. %	1975** No. %	1976 * No. %	1977 * No. %	1978 * No. %	1973-78 No. %
Sexually immature	23 46.9						29 40.3
Sexually mature:							
Condition undetermined	11 22.5						13 18.1
Pregnant only	3 6.1						8 11.1
Pregnant and lactating	0 0.0						2 2.8
Lactating only	11 22.5						19 26.4
"Resting"							
With corpus luteum	0 0.0						0 0.0
Without corpus luteum	1 2.0						1 1.4
Postreproductive	0 0.0						0 0.0
Totals:	49 100.0						72 100.0

* Insufficient data

** No specimens

Table 16. Reproductive condition of 72 female northern tropical common dolphins, Delphinus delphis, collected 1973-1978.

Item	1973	1974**	1975**	1976*	1977*	1978 *	1973-1978
Sample size (no.)	15	--	--	--	--	--	30
Pregnancy (mo.)	11.5	--	--	--	--	--	11.5
Lactation (mo.)							
Method 1	42.2	--	--	--	--	--	24.2
Method 2 (Hyp.II)	--	--	--	--	--	--	--
"Resting" (Method 1)	3.8	--	--	--	--	--	1.2
Sum of Phases:							
Method 1							
Months	57.5	--	--	--	--	--	36.8
Years	4.79	--	--	--	--	--	3.07
Method 2							
Months	--	--	--	--	--	--	--
Years	--	--	--	--	--	--	--
Annual Pregnancy Rate (APR):							
Method 1	0.209	--	--	--	--	--	0.348
Method 2	--	--	--	--	--	--	--
Calving Interval (1/APR):							
Method 1							
Years	4.79	--	--	--	--	--	2.88
Months	57.5	--	--	--	--	--	34.5
Method 2							
Months	--	--	--	--	--	--	--
Years	--	--	--	--	--	--	--

* Insufficient data

** No specimens

Table 17. Estimates of lengths of reproductive phases, pregnancy rate, and calving interval of the northern tropical common dolphin, Delphinus delphis, 1973-1978.

Year	A Proportion female	B Proportion of females reproductive	C		A x B x C	
			Annual pregnancy rate Method 1	Method 2	Gross annual reproductive rate Method 1	Method 2
1973	0.557 $\pm$ (-)* (88)	0.531 $\pm$ (-)* (49)	0.209 $\pm$ (-)* (15)	---	0.062 $\pm$ (-)* (78)	---
1974**	---	---	---	---	---	---
1975**	---	---	---	---	---	---
1976*	---	---	---	---	---	---
1977*	---	---	---	---	---	---
1978*	---	---	---	---	---	---
1973-1978	0.514 $\pm$ 0.042 (140)	0.597 $\pm$ (-)* (72)	0.348 $\pm$ (-)* (30)	---	0.109 $\pm$ 0.068 (128)	---

* Insufficient data

** No specimens

Table 18. Calculation of estimates of gross annual reproductive rate of the northern tropical common dolphin, Delphinus delphis. Standard error follows estimate (see text). Sample size in parentheses.

	1973 *	1974 *	1975 *	1976 *	1977 *	1978 *	1973-78
	No.	No.	No.	No.	No.	No.	No.
	%	%	%	%	%	%	%
Sexually immature							4
Sexually mature:							14.3
Condition undetermined							15
Pregnant only							53.6
Pregnant and lactating							3
Lactating only							10.7
"Resting"							0
With corpus luteum							0.0
Without corpus luteum							5
Postreproductive							17.9
							0
							0.0
							1
							3.6
							0
							0.0
							35.7
Totals:							28
							100.0

* Insufficient data

** No specimens

Table 19. Reproductive condition of 28 female Baja Neritic common dolphins, Delphinus delphis, collected 1973-1978.

Item	1973*	1974*	1975**	1976**	1977*	1978 *	1973-1978
Sample size (no.)	--	--	--	--	--	--	56
Pregnancy (mo.)	--	--	--	--	--	--	11.5
Lactation (mo.)							
Method 1	--	--	--	--	--	--	19.2
Method 2 (Hyp.II)	--	--	--	--	--	--	--
"Resting" (Method 1)	--	--	--	--	--	--	3.8
Sum of Phases:							
Method 1							
Months	--	--	--	--	--	--	34.5
Years	--	--	--	--	--	--	2.88
Method 2							
Months	--	--	--	--	--	--	--
Years	--	--	--	--	--	--	--
Annual Pregnancy Rate							
(APR):							
Method 1	--	--	--	--	--	--	0.348
Method 2	--	--	--	--	--	--	--
Calving Interval							
(1/APR):							
Method 1							
Years	--	--	--	--	--	--	2.88
Months	--	--	--	--	--	--	34.5
Method 2							
Months	--	--	--	--	--	--	--
Years	--	--	--	--	--	--	--

* Insufficient data

** No specimens

Table 20. Estimates of lengths of reproductive phases, pregnancy rate, and calving interval of the Baja Neritic common dolphin, Delphinus delphis, 1973-1978.

Year	A Proportion female	B Proportion of females reproductive	C		A x B x C	
			Annual pregnancy rate Method 1	Method 2	Gross annual reproductive rate Method 1	Method 2
1973*	---	---	---	---	---	---
1974*	---	---	---	---	---	---
1975*	---	---	---	---	---	---
1976**	---	---	---	---	---	---
1977*	---	---	---	---	---	---
1978*	---	---	---	---	---	---
1973-1978	$0.500 \pm (-)^*$ (56)	$0.857 \pm (-)^*$ (28)	$0.348 \pm (-)^*$ (9)	---	$0.149 \pm (-)^*$ (42)	---

* Insufficient data

** No specimens

Table 21. Calculation of estimates of gross annual reproductive rate of the Baja Neritic common dolphin, Delphinus delphis. Standard error follows estimate (see text). Sample size in parentheses.

	1973 No.	1973 %	1974 No.	1974 %	1975 No.	1975 %	1976 * No.	1976 * %	1977 No.	1977 %	1978 * No.	1978 * %	1973-78 No.	1973-78 %
Sexually immature	49	46.2	44	38.6	63	55.3			134	62.0			325	51.9
Sexually mature:														
Condition undetermined	12	11.3	10	8.8	14	12.3			25	11.6			79	12.6
Pregnant only	9	8.5	23	20.2	10	8.8			10	4.6			56	8.9
Pregnant and lactating	5	4.7	1	0.9	9	7.9			11	5.1			27	4.3
Lactating only	20	18.9	32	28.1	13	11.4			30	13.9			112	17.9
"Resting"														
With corpus luteum	5	4.7	2	1.7	5	4.4			2	0.9			15	2.4
Without corpus luteum	6	5.7	2	1.7	0	0.0			4	1.9			12	1.9
Postreproductive	0	0.0	0	0.0	0	0.0			0	0.0			0	0.0
Totals:	106	100.0	114	100.0	114	100.0			216	100.0			626	100.0

* Insufficient data

** No specimens

Table 22. Reproductive condition of 626 female east central tropical common dolphins, Delphinus delphis, collected 1973-1978.

Item	1973	1974	1975	1976*	1977	1978*	1973-1978
Sample size (no.)	45	60	37	14	57	9	222
Pregnancy (mo.)	11.5	11.5	11.5	--	11.5	--	11.5
Lactation (mo.)							
Method 1	20.5	15.8	13.3	--	22.5	--	19.3
Method 2 (Hyp.II)	--	--	--	--	--	--	--
"Resting" (Method 1)	9.0	1.9	3.0	--	3.3	--	3.7
Sum of Phases:							
Method 1							
Months	41.1	29.2	27.8	--	37.2	--	34.5
Years	3.42	2.44	2.32	--	3.10	--	2.88
Method 2							
Months	--	--	--	--	--	--	--
Years	--	--	--	--	--	--	--
Annual Pregnancy Rate (APR):							
Method 1	0.325	0.417	0.536	--	0.385	--	0.390
Method 2	--	--	--	--	--	--	--
Calving Interval (1/APR):							
Method 1							
Years	3.08	2.40	1.87	--	2.60	--	2.56
Months	37.0	28.8	22.4	--	31.2	--	30.8
Method 2							
Months	--	--	--	--	--	--	--
Years	--	--	--	--	--	--	--

* Insufficient data

** No specimens

Table 23. Estimates of lengths of reproductive phases, pregnancy rate, and calving interval of the east central tropical common dolphin, Delphinus delphis, 1973-1978.

Year	A	B	C	A x B x C	
				Annual pregnancy rate	
				Method 1	Method 2
Year	Proportion female	Proportion of females reproductive	Annual pregnancy rate	Gross annual reproductive rate	
				Method 1	Method 2
				Method 1	Method 2
1973	0.453 $\pm$ 0.033 (234)	0.528 $\pm$ 0.052 (106)	0.325 $\pm$ (-)* (45)	0.078 $\pm$ 0.018 (222)	---
1974	0.514 $\pm$ 0.034 (222)	0.614 $\pm$ 0.048 (114)	0.417 $\pm$ (-)* (60)	0.132 $\pm$ 0.023 (210)	---
1975	0.523 $\pm$ 0.034 (218)	0.447 $\pm$ 0.051 (114)	0.536 $\pm$ (-)* (37)	0.125 $\pm$ 0.023 (199)	---
1976*	--- (83)	---	---	---	---
1977	0.477 $\pm$ 0.023 (455)	0.373 $\pm$ 0.036 (217)	0.385 $\pm$ (-)* (57)	0.068 $\pm$ 0.012 (417)	---
1978*	---	---	---	---	---
1973-1978	0.493 $\pm$ 0.014 (1,273)	0.477 $\pm$ 0.022 (627)	0.390 $\pm$ 0.033 (222)	0.092 $\pm$ 0.008 (1,160)	---

* Insufficient data

** No specimens

Table 24. Calculation of estimates of gross annual reproductive rate of the east central tropical common dolphin, Delphinus delphis. Standard error follows estimate (see text). Sample size in parentheses.

	1973	1974	1975	1976	1977	1978	1973-78
	No.	No.	No.	No.	No.	No.	No.
	%	%	%	%	%	%	%
Sexually immature	79	46	67	27	132	18	367
Sexually mature:	50.6	39.3	56.8	43.5	55.2	35.3	49.5
Condition undetermined							
Pregnant only	17	11	14	8	44	15	110
Pregnant and lactating	12	23	10	7	10	8	70
Lactating only	5	1	9	2	11	1	29
"Resting"	31	32	13	18	36	7	137
With corpus luteum	5	2	5	0	2	1	15
Without corpus luteum	7	2	0	0	4	1	14
Postreproductive	0	0	0	0	0	0	0
Totals:	156	117	118	62	239	51	742
	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 25. Reproductive condition of 742 female common dolphins, Delphinus delphis, collected 1973-1978. (All stocks)

Item	1973	1974	1975	1976	1977	1978	1973-1978
Sample size (no.)	60	60	37	27	63	18	265
Pregnancy (mo.)	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Lactation (mo.)							
Method 1	24.4	15.8	13.3	25.6	25.7	10.2	19.3
Method 2 (Hyp.II)	--	--	--	--	--	--	--
"Resting" (Method 1)	8.1	1.9	3.0	0.0	3.3	2.6	3.4
Sum of Phases:							
Method 1							
Months	44.0	29.2	27.8	37.1	40.5	24.3	34.2
Years	3.66	2.44	2.32	3.09	3.34	2.02	2.85
Method 2							
Months	--	--	--	--	--	--	--
Years	--	--	--	--	--	--	--
Annual Pregnancy Rate (APR):							
Method 1	0.296	0.417	0.536	0.348	0.348	0.522	0.390
Method 2	--	--	--	--	--	--	--
Calving Interval (1/APR):							
Method 1							
Years	3.38	2.40	1.87	2.88	2.88	1.92	2.57
Months	40.6	28.8	22.4	34.5	34.5	23.0	30.8
Method 2							
Months	--	--	--	--	--	--	--
Years	--	--	--	--	--	--	--

Table 26. Estimates of lengths of reproductive phases, pregnancy rate, and calving interval of the common dolphin, Delphinus delphis, 1973-1978. (All stocks)

Year	A Proportion female	B Proportion of females reproductive	C		A x B x C	
			Annual pregnancy rate Method 1	Method 2	Gross annual reproductive rate Method 1	Method 2
1973	0.447 $\pm$ 0.028 (329)	0.484 $\pm$ 0.044 (157)	0.296 $\pm$ (-)* (60)	---	0.068 $\pm$ 0.014 (303)	---
1974	0.511 $\pm$ 0.033 (229)	0.607 $\pm$ 0.048 (117)	0.417 $\pm$ (-)* (60)	---	0.129 $\pm$ 0.023 (215)	---
1975	0.522 $\pm$ 0.033 (226)	0.432 $\pm$ 0.050 (118)	0.534 $\pm$ (-)* (37)	---	0.121 $\pm$ 0.023 (206)	---
1976	0.530 $\pm$ 0.069 (117)	0.565 $\pm$ (-)* (62)	0.348 $\pm$ (-)* (27)	---	0.104 $\pm$ 0.030 (107)	---
1977	0.470 $\pm$ 0.022 (508)	0.444 $\pm$ 0.037 (239)	0.348 $\pm$ (-)* (63)	---	0.073 $\pm$ 0.012 (447)	---
1978	0.515 $\pm$ (-)* (99)	0.647 $\pm$ (-)* (51)	0.522 $\pm$ (-)* (18)	---	0.174 $\pm$ (-)* (83)	---
1973-1978	0.493 $\pm$ 0.013 (1,508)	0.501 $\pm$ 0.021 (744)	0.390 $\pm$ 0.030 (265)	---	0.096 $\pm$ 0.008 (1,333)	---

* Insufficient data

Table 27. Calculation of estimates of gross annual reproductive rate of all stocks of the common dolphin, Delphinus delphis. Standard error follows estimate (see text). Sample size in parentheses.

	1973* No.	1973* %	1974* No.	1974* %	1975 No.	1975 %	1976* No.	1976* %	1977** No.	1977** %	1978* No.	1978* %	1973-78 No.	1973-78 %
Sexually immature					9	40.9							19	46.3
Sexually mature:														
Condition undetermined					1	4.5							6	14.6
Pregnant only					5	22.7							6	14.6
Pregnant and lactating					1	4.5							1	2.4
Lactating only					4	18.2							6	14.6
"Resting"														
With corpus luteum					0	0.0							0	0.0
Without corpus luteum					2	9.1							3	7.3
Postreproductive					0	0.0							0	0.0
Totals:					22	100.0							41	100.0

* Insufficient data

** No specimens

Table 28. Reproductive condition of 41 female east central tropical striped dolphins, Stenella coeruleoalba, collected 1973-1978.

Item	1973*	1974*	1975	1976*	1977**	1978*	1973-1978
Sample size (no.)	--	--	12	--	--	--	16
Pregnancy (mo.)	--	--	11.5	--	--	--	11.5
Lactation (mo.)							
Method 1	--	--	9.6	--	--	--	11.5
Method 2 (Hyp.II)	--	--	--	--	--	--	--
"Resting" (Method 1)	--	--	3.8	--	--	--	4.9
Sum of Phases:							
Method 1							
Months	--	--	24.9	--	--	--	27.9
Years	--	--	2.08	--	--	--	2.33
Method 2							
Months	--	--	--	--	--	--	--
Years	--	--	--	--	--	--	--
Annual Pregnancy Rate							
(APR):							
Method 1	--	--	0.522	--	--	--	0.457
Method 2	--	--	--	--	--	--	--
Calving Interval							
(1/APR):							
Method 1							
Years	--	--	1.92	--	--	--	2.19
Months	--	--	23.0	--	--	--	26.3
Method 2							
Months	--	--	23.0	--	--	--	26.3
Years	--	--	1.92	--	--	--	2.19

* Insufficient data

** No specimens

Table 29. Estimates of lengths of reproductive phases, pregnancy rate, and calving interval of the east central tropical striped dolphin, Stenella coeruleoalba, 1973-1978.

Year	A Proportion female	B Proportion of females reproductive	C		A x B x C	
			Annual pregnancy rate Method 1	Annual pregnancy rate Method 2	Gross annual reproductive rate Method 1	Gross annual reproductive rate Method 2
1973*	---	---	---	---	---	---
1974*	---	---	---	---	---	---
1975	0.489 $\pm$ (-)* (45)	0.591 $\pm$ (-)* (22)	0.522 $\pm$ (-)* (12)	---	0.151 $\pm$ (-)* (44)	---
1976*	---	---	---	---	---	---
1977**	---	---	---	---	---	---
1978*	---	---	---	---	---	---
1973-1978	0.506 $\pm$ (-)* (81)	0.537 $\pm$ (-)* (41)	0.457 $\pm$ (-)* (16)	---	0.124 $\pm$ (-)* (80)	---

* Insufficient data

** No specimens

Table 30. Calculation of estimates of gross annual reproductive rate of the east central tropical striped dolphin, *Stenella coeruleoalba*. Standard error follows estimate (see text). Sample size in parentheses.

	1973*	1974*	1975	1976*	1977 *	1978	1973-78
	No.	No.	No.	No.	No.	No.	No.
	%	%	%	%	%	%	%
Sexually immature			12				43
Sexually mature:							
Condition undetermined			1				16
Pregnant only			6				8
Pregnant and lactating			1				2
Lactating only			5				7
"Resting"							
With corpus luteum			0				0
Without corpus luteum			3				4
Postreproductive			0				0
Totals:			28				80
			100.0				100.0

-47-

* Insufficient data

** No specimens

Table 31. Reproductive condition of 80 female striped dolphins, Stenella coeruleoalba, collected 1973-1978. (All stocks)

Item	1973*	1974*	1975	1976*	1977*	1978*	1973-1978
Sample size (no.)	--	--	14	--	--	--	21
Pregnancy (mo.)	--	--	11.5	--	--	--	11.5
Lactation (mo.)							
Method 1	--	--	9.9	--	--	--	10.4
Method 2 (Hyp.II)	--	--	--	--	--	--	--
"Resting" (Method 1)	--	--	4.9	--	--	--	4.6
Sum of Phases:							
Method 1							
Months	--	--	26.3	--	--	--	26.5
Years	--	--	2.19	--	--	--	2.21
Method 2							
Months	--	--	--	--	--	--	--
Years	--	--	--	--	--	--	--
Annual Pregnancy Rate							
(APR):							
Method 1	--	--	0.487	--	--	--	0.497
Method 2	--	--	--	--	--	--	--
Calving Interval							
(1/APR):							
Method 1							
Years	--	--	2.05	--	--	--	2.01
Months	--	--	24.6	--	--	--	24.2
Method 2							
Months	--	--	--	--	--	--	--
Years	--	--	--	--	--	--	--

* Insufficient data

** No specimens

Table 32. Estimates of lengths of reproductive phases, pregnancy rate, and calving interval of the striped dolphin, Stenella coeruleoalba, 1973-1978. (All stocks)

Year	A Proportion female	B Proportion of females reproductive	C		A x B x C	
			Annual pregnancy rate Method 1	Method 2	Gross annual reproductive rate Method 1	Method 2
1973*	--- (18)	---	---	---	---	---
1974*	--- (16)	---	---	---	---	---
1975	0.538 $\pm$ (-)* (52)	0.571 $\pm$ (-)* (28)	0.487 $\pm$ (-)* (15)	---	0.150 $\pm$ (-)* (51)	---
1976*	---	---	---	---	---	---
1977*	--- (11)	---	---	---	---	---
1978*	--- (24)	---	---	---	---	---
1973-1978	0.476 $\pm$ 0.039 (168)	0.463 $\pm$ (-)* (80)	0.497 $\pm$ (-)* (21)	---	0.109 $\pm$ 0.025 (155)	---

* Insufficient data

** No specimens

Table 33. Calculation of estimates of gross annual reproductive rate of all stocks of the striped dolphin, Stenella coeruleoalba. Standard error follows estimate (see text). Sample size in parentheses.

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